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ABSTRACT

This guide to the "Measuring in Metric" supplementary mathematics textbook is the modified version for the physically handicapped student. The material begins with a list of 29 student objectives. The booklet and student text limit exploration to the units of measurement for length, capacity, mass, temperature, area, and volume, with only the following prefixes considered: kilo, hecto, deka, deci, centi, and milli. The guide breaks down the student book by sections, with objectives, materials needed, helpful comments, special arrangement suggestions for students with physical disabilities, and ideas for other activities. In addition, the guide contains a metric game, a master outline of a box needed for one section of the text, a detailed list of supplies and equipment needed, three quizzes and a test, and an answer key to problems found in the student text. (MP)

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MEASURING IN METRIC

(PHYSICALLY-HANDICAPPED VERSION)

TEACHER'S MANUAL

SE 033 930

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1979

TEACHER'S MANUAL
for
Measuring in Metric
(Physically-handicapped version)

OBJECTIVES

1. Given a length or distance to be measured and a choice of three metric measurements, select the measurement which is the best approximation of that length or distance.

2. Given a length or distance to be measured and a choice of *mm*, *cm*, *m*, and *km*, select the most appropriate unit for determining that length or distance.

3. Given a meter stick, centimeter ruler or millimeter ruler, determine the length of a given object.

4. Given a specified length measure and three choices of objects or distances, select the most appropriate object or distance.
   e.g. 20 *cm* ⟶ new pencil thumbnail broom handle

5. Given a length of 0.1 centimeter, use the centimeter ruler and draw the length.

6. Recall personal height in *cm*.

7. Given a polygon or a curved figure, find the perimeter.

8. Recognize the difference between the area and perimeter.

9. Given a region and choice of cm^2, dm^2, m^2, and km^2, select the most appropriate unit for determining the area of that region.

10. Given a space and choice of cm^3, dm^3, and m^3, select the most appropriate unit for determining the volume of that space.

11. Given the name of a container and a choice of three metric measurements, select the measurement which is the best approximation of that container's capacity.

12. Given the name of a container and a choice of *ml*, *l* and *kl*, select the most appropriate unit for determining the capacity of that container.

13. Given a liter measure or a graduated cylinder calibrated in milliliters, determine the capacity of a container.

14. Given a specified capacity measurement and three choices of containers, select the most appropriate container.
   e.g. 2 *l* ⟶ soup can half-gallon milk carton oil drum

15. Given the name of an object and a choice of three metric measurements, select the measurement which is the best approximation of that object's mass.

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16. Given the name of an object and a choice of *mg* , *g* and *kg* , select the most appropriate unit for determining the mass of that object.

17. Given a scale calibrated in grams or kilograms, determine the mass of a given object.

18. Given a specified measure of mass and three choices of object, select the most appropriate object.
    e.g. 3 *kg* ⟶ a car candy bar 10 lbs. of sugar

19. Recall personal weight in *kg* .

20. Given a situation involving temperature and a choice of three temperatures in degrees Celsius, select the temperature which is the best approximation of that situation.

21. Given a clinical thermometer, read temperatures to the nearest tenth of a degree.

22. Recall the temperatures 100°C , 0°C , 37°C , and 20° – 30°C as the boiling point of water, the freezing point of water, the normal body temperature, and the normal temperature in Hawaii, respectively.

23. Write metric measures using accepted symbolism as determined by SI.

24. Recall the meanings of six metric prefixes: *kilo-* means thousand, *hecto-* means hundred, *deka-* means ten, *deci-* means tenth, *centi-* means hundredth, and *kilo-* means thousandth.

25. Given three, four, five or six decimal numbers with at most three decimal places, find their sum.

26. Given a pair of numbers with at most three decimal places, find their difference.

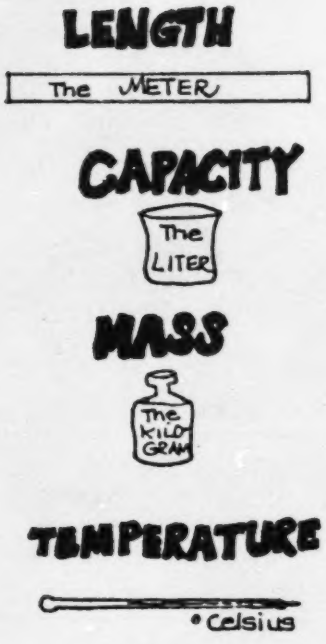
27. Given a pair of numbers with at most three decimal places, find their product.

28. Recall the approximate relationships: 1 meter is a little longer than a yard, 1 liter is a little more than a quart, a little more than 2 centimeters is an inch, 5 miles is about 8 kilometers, 1 kilogram is more than 2 pounds.

29. Given a common metric measurement, convert it to another specified unit.
    e.g. 2 *m* = _____ *cm* 35 *ml* = _____ *l*

ABOUT THE METRIC SYSTEM

The International System of Units (SI) is built on seven base units and other units that are derived from these base units. The system includes a prefix for each power of ten from *exo-* (10^{18}) to *atto-* (10^{-18}). In this booklet, only the units of measurement for length, capacity, mass, temperature, area, and volume will be studied; and only the six frequently used prefixes (*kilo-*, *hecto-*, *deka-*, *deci-*, *centi-*, *milli-*) will be considered.



The base SI unit for length is the meter. (Sometimes spelled metre, but the -er spelling is recommended for non-technical work.) Other commonly used units of length are centimeter, millimeter and kilometer.

The liter (also spelled litre) is another name for a standard unit of volume, the cubic decimeter. Most commonly used capacity units are liter, milliliter, and kiloliter.

The base SI unit for mass is the kilogram. A kilogram mass is approximately equal to 2.2 pounds. Other commonly used mass units are gram and milligram. The unit of mass of very large objects is the metric ton. In this booklet, the word weight will be used to mean the same as mass.

The Celsius scale is used to measure temperature in practical situations. The base unit, Kelvin, is used for most scientific work.

Symbols in SI are not followed by a period. A space is left between the numeral and the unit. A metric measurement less than one unit must include a zero before the decimal point. For example, 0.32 *m* is the notation for thirty-two hundredths meter.

Consult the following references for further information about the metric system:

Averett, D., Crump, B., & Rosenbaum, G. Think Metric, Level Green. New York: William H. Sadlier Inc., 1976.

Bright, G., & Thacker, M. Activities to Go Metric, Booklet C. Glenview: Scott, Foresman & Co., 1975.

Kempf, A., & Richards, T. Using the Metric System. River Forest: Laidlaw Bros., 1973.

Kempf, A., & Richards, T. Exploring the Metric System. River Forest: Laidlaw Bros., 1973.

Mark, F. Exploring Metrics. New York: Globe Book Co., Inc., 1976.

May, L., & Jacobs, D. Measure Metric, Book D. New York: Harcourt Brace & Jovanovich, 1974.

Odom, J. (Ed.). Successful Experiences in Teaching Metric (NBS Special Publication 441). Washington, D.C.: U. S. Department of Commerce, National Bureau of Standards, January 1976.

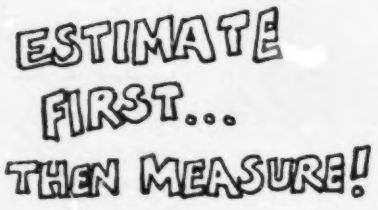
Whitman, N., & Braun, F. The Metric System: A Laboratory Approach for Teachers. New York: Wiley & Sons, 1978.

Also, the Arithmetic Teacher and the Mathematics Teacher, journals published by the National Council of Teachers of Mathematics, frequently include reviews of new metric books and materials.

Two other versions of this booklet are available: Measuring in Metric (for use in the regular classroom) and Learning About the Metric System in High School.

ABOUT THE STUDENT'S BOOKLET

Measuring in Metric is written to acquaint intermediate school students with the commonly used prefixes and measurement units in the metric system through estimation and measurement activities, frame-of-reference activities, abstraction and conversion activities, and change-of-pace activities. The teacher can extend and adapt these activities to fit special situations that may arise in the classroom.



In the estimation and measurement activities, students are asked to estimate and measure objects using common metric units. Estimations will be refined as students develop a familiarity with the units. Measuring objects helps students build reference objects for various metric units and develop mental pictures of relative size of the metric units.

Frame-of-reference activities require the student to read a description of a situation and either select the most appropriate measurement or select the most appropriate unit for measuring the object.

Abstraction and conversion activities require the student to find equivalent measurements within the metric system. maintain computational skill with decimals, and compare (order) measurements.

Change-of-pace activities are incorporated to provide for variation in the lessons. Four-star problems ("brainbusters") that are related to a storyline on the top of the page are found throughout the booklet.

Upon completion of this booklet, the student should be able to:

1) Name the main metric units for length, capacity, mass, temperature, area, and volume.
2) Write the six common metric prefixes and their numerical values.
3) Measure using appropriate instruments.
4) Estimate measurement of common objects using metric units.
5) Express one metric unit in terms of another specified metric unit.

SUGGESTIONS FOR TEACHING MEASURING IN METRIC (Physically-handicapped version)

This version of Measuring in Metric has been developed for physically-handicapped students. However, different students will have different limitations and the teacher may need to adapt or eliminate certain exercises or activities for some students.

To aid the teacher in teaching this unit, an outline of objectives, materials needed, comments, and suggestions for other activities are provided on the following pages for each lesson. Also included are masters for quizzes

and a test which could be used for pre-testing and post-testing. Answers to the student pages are provided at the end of the commentary. Teachers may want to transfer these answers to the pages of a student booklet for easier reference.

The teacher is encouraged to keep a log of the daily lessons on the space provided next to the outline. Questions, such as, "How can I teach this better the next time?", "Were materials sufficient?", "Is the activity more successful working in pairs or individually?", "Can I extend the lesson for the faster students?", etc., can be answered in the daily log.

Pages 1 to 2 Introduction

Objective: Understand the use of and need for the metric system.

Materials: None

Comments: Begin discussing the metric system by asking students how many have heard of it. Who uses the metric system? Can they give examples of the metric system being used in this country (state)? Examples might include buying gasoline by the liter and running in a ten kilometer race. What are some of the pros and cons of the metric system with which the students are familiar? Why should the metric system be studied? Have the class read pages 1 and 2 of the student book.

WHY METRIC?

Other activities:

1) Have the students ask their parents what they know about the metric system. Do their parents ever see or use the metric units?

2) Have the students determine if any of the metric units are used in grocery stores, in department stores, in government offices, and so on.

3) Start a bulletin board display of examples of the metric system in use. Add examples provided by the students whenever possible.

Pages 3 to 5 Metric Rulers

Objective: Know the names of common metric rulers.

Materials: Meter sticks (about 6)
Adding machine tape (1 roll) cut off into longer than 1 meter lengths--one for each student
Scissors (enough to be shared in the classroom)

Oak tag or other hard paper (28 *cm* x 5 *cm*)
--one for each student
Glue (about 6 bottles)

Comments: The beginning activity in these pages provides the students with a meter "stick," centimeter ruler and millimeter ruler for use throughout the remainder of this book.

ORGANIZE!

While some students are using the classroom meter sticks to cut off their meter strips, other students can be working on cutting and pasting their centimeter and millimeter rulers. This can be completed with a minimum of confusion, but organization and management are very important.

Have students work in pairs to verify measurements.

The exercises on pages 3-5 require the students to compare the different metric units. Rules for computing conversions should not be emphasized. Students should be encouraged to discuss any patterns they notice and to state generalizations. They might note things such as

--the number of millimeters is always larger than the number of centimeters.

--you can't just "add a zero" to the end of the number; it doesn't always work.

--the decimal moves one place to the left (right) when changing from centimeters to millimeters (or vice-versa).

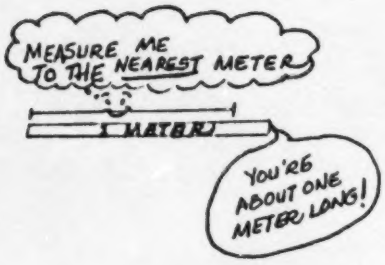
Other activities:
Students may start a bulletin board display. They may use tacks or glue to attach a string 1 meter long to the board. Other units are attached as they are studied. They may also start a list of real life objects that are about 1 meter long.

Pages 6 to 8 Length (The Meter)

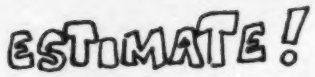
Objectives: Measure to the nearest meter.
Build frame-of-reference for the meter.

Materials: Classroom demonstration meter sticks
Each student should have his own one-meter tape.

Comments: Emphasize that the meter is the main metric unit of length. All other units are derived from it.



In exercise 2, the measurement activity asks students to measure to the nearest meter. Be sure students understand what is meant by measuring to the nearest unit. Discrepancies in students' answers should be resolved by having students with different answers explain how they arrived at their answers.



Be sure students are familiar with estimation. The teacher might want to first estimate and then measure one of the items in exercise 2 with the entire class.

Students should recognize the usefulness of having "body meter sticks" -- armlengths for facilitating estimates of lengths of objects; strides for estimating distances.

Exercise 3 may be difficult or impossible for some handicapped students. If so, the teacher should demonstrate the concept of an armlength meter stick for these students.

Contests may be held to see who is the best guesser for the lengths in exercise 4.

In exercise 7 the trundle wheel is convenient but its use is optional.

Participation of parents may be encouraged by having students take home a copy of exercise 8. Students may compare their answers to those of their parents.

Have a contest before doing exercise 9. Who can produce the longest list of objects about 1 meter long? Exercise 9 forces students to visualize lengths of 1 meter around them.

Note: Before assigning exercises 2 and 4 find the exact measurements of each object. Students will want to know if their work is accurate.

Other activities:

1) Point to a section of the chalkboard and have students guess the length to the nearest meter.
   Record the guesses on the board.

Select a student to measure the chalkboard section and write the measurement on the board.

2) Have students interview three people during the day and ask, "How long is a meter?" Record their findings on the board to determine what percent of people interviewed generally know how long a meter is.

Pages 9 to 11 Length (The Centimeter)

Objective: Measure to the nearest centimeter.

Materials: Centimeter ruler
String (about 60 *cm* long -- enough to be shared in the class)
Metric height measurement chart (taped on a wall)

Comments: Be sure students understand what is meant by measuring something to the nearest unit.

In exercises 4 and 5, students will need string to obtain measurements. Encourage students to use lengths of familiar objects, such as body parts, to sharpen estimation skills.

Other activities:

1) Have students work in pairs. One student draws five line segments and the partner estimates and measures their lengths. Partners then alternate their activities. Do this until each student can correctly estimate four out of five times.

2) Have each student guess the length of an object. Select a different item for each student. The length of the object will then be measured and the best guesser is chosen.

3) On the bulletin board students may attach pieces of string and label them "about 25 *cm*," "about 60 *cm*," etc.

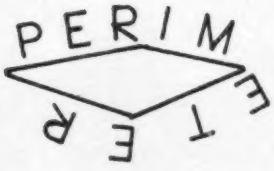
4) Have a contest among pairs of students. Give each pair a length such as 2 *cm*, 3 *cm*, 4 *cm*, and so on. Who can locate and write down the most objects with each length? Special attention may be given to locating parts of wheelchairs with these lengths. These lists may be placed on the bulletin board and added to as new objects are found.

Pages 12 to 14 Perimeter

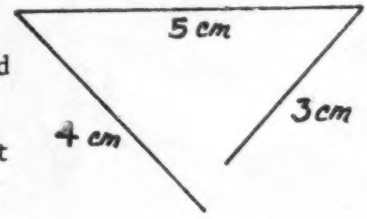
Objective: Find perimeters of polygons and curved figures.

Materials: String
Centimeter ruler

Comments: There is a tendency for students to confuse perimeter and area. The diagram on page 12 was intended to "summarize" the idea of perimeter.



For exercise 3, students are most likely to draw first a figure that is not a polygon. Encourage them to use trial and error when drawing a closed figure (polygon). The figure shown has a length of 12 *cm* but we do not say, "Its perimeter is 12 *cm*." because perimeter means distance around.



In exercise 5, students may measure the objects in various ways. This may be done by using a meter stick, a paper meter, or a string, which is first stretched around the edges and then measured. They should decide the best method for measuring each object.

In exercise 6, students should describe various ways of finding the perimeter of the flag.

Pages 15 to 17 Length (The Millimeter)

Objectives: Measure to the nearest millimeter.
Add and subtract measurements.

Materials: Millimeter ruler
Five nails of different lengths, labeled
A, B, C, D, E
Coins -- penny, nickel, dime, quarter

Comments: The need for a unit smaller than the centimeter can be suggested by measuring such objects as the thickness of eight sheets of paper or the thickness of a dime.

The nails and coins used in exercises 1 and 2 may create classroom management problems. They should be placed in different parts of the room to avoid congestion or they can be passed around. If available, duplicate sets of nails would be helpful.

When measuring in millimeters, expect minor variations in answers.

Other activities:

1) For a five-minute activity, have students estimate the lengths of various objects. This activity can be done throughout the year.

2) Have students bring to class objects, such as gum wrappers, candy wrappers, etc. and display on the bulletin board with the measurement of the length and/or width shown.

3) For exercise 3, students may also measure the perimeter to the nearest centimeter. They should discuss why the perimeter in the example is 76 *mm* and 8 *cm* (80 *mm*) when measured to the nearest centimeter.

Pages 18 to 22 Length (The Kilometer)

Objectives: Know that 1 *km* is shorter than a mile
and 8 *km* is about 5 miles.
Recognize and extend a pattern.

Materials: None

Comments: Reading tables should be demonstrated on the overhead.

Make sure the students understand why the "X" appears in some of the regions on the table. Why aren't there numbers in these spaces?

Encourage students to do the 1 kilometer homework activity. For exercise 2, emphasize that a measurement is shown by a numeral and a unit. This is a good time to review symbols in SI.

For the field trip in exercise 5, students should describe routes in exercises a, b, and c carefully: Go mauka on _____ Street to _____ Street. Turn right. Stop at the corner of _____ Street and _____ Street. In exercise d, the sketch should show turns and names of streets. In exercise e, the two-kilometer distances should be along streets.

The projects in exercises 7-9 are optional. They might be completed as homework after the necessary data is collected. Other projects included in this booklet are also optional.

Other activities:

1) Have students describe locations north, east, south and west of their homes that are 1 *km* away. Others in the class will guess the approximate location of that student's home.

2) Have students construct a speedometer scale for the family car in kilometers.

3) Students may determine the distances in kilometers from known locations on a street map of their city.

Pages 23 to 27 Length

Objectives: Use the units of length and their symbols.

Recall the meanings of the six metric prefixes.

Select the best measurement.

Select the most appropriate unit.

Materials: Meter, centimeter, and millimeter rulers

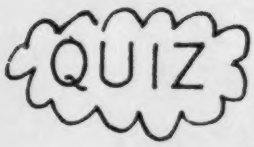
Comments: This lesson reviews the commonly used metric units of length. Students should develop familiarity with the metric prefixes and their meanings.

Other activities:

1) Students work in pairs. Each pair decides on the length or distance of 4 objects that everyone knows using each of the four common units (*m*, *cm*, *mm*, *km*).
   For example:
   Diameter of an apple 7 *cm*
   Length of a bobby pin 50 *mm*
   Distance from Ala Moana to Downtown 3 *km*
   Students then present their examples to the rest of the class and the class chooses the two best examples for each of the units.

2) Divide the class into four groups. One group is assigned to draw (or cut out) pictures of 3 objects known to everyone. Each picture must be labeled "shorter than 1 meter," "longer than 1 meter," or "about 1 meter." The second group does the same with *cm*. The third group does the same with *mm* and the fourth group with *km*. Display the pictures with their labels on the bulletin board.
   You may wish to replace exercises 12-14 with this activity. Many students will profit by doing both.

3) Have students make up problems such as exercises 6-9. You may suggest objects, events or the activities of pupils such as the length of a surfboard, the height of The Bus, the height of a newborn baby, the diameter of the eraser of a pencil, and so on.



Quiz 1 can be given at this time.

Pages 28 to 35 Area

Objectives: Determine area in dm^2 by covering a region with squares.
Determine area in cm^2 by counting squares.
Select cm^2, m^2 or km^2 as the appropriate unit for measuring area.
Recognize the difference between area and perimeter.

Materials: Construction paper or index card (5" x 8")
Centimeter rulers
Scissors

Comments: Work with the square decimeter is intended to give students the experience of "covering" an unmarked region with squares. (Later, work with square centimeters show regions already marked off into squares.)

In exercise 2, be sure students understand the term polygon.

Counting parts of squares and putting them together to make whole squares should be emphasized. In exercise 3, an approximation for the area can be obtained by adding the number of full squares with one-half the number of partial squares. Exercise 6 will be a challenge for many students. Keeping the fingers together in outlining the hand will make finding the approximate area easier.

To lessen confusion that often occurs between area and perimeter, exercise 7 requires students to find both area and perimeter. Emphasize the difference in units (square centimeter vs. centimeter).

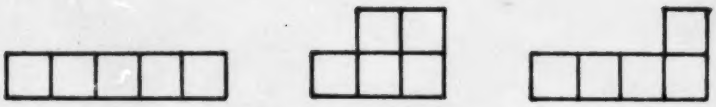
Other activities:

1) Have students use grid paper and draw rectangles 2 x 3, 1 x 4, 5 x 7, etc. and discover the formula for finding area of a rectangle using base (b) and height (h). $A = b \times h$
Do the same for finding the area of a triangle.
Better students may be challenged to discover a formula for finding area of a trapezoid.

2) Using the geoboard, discover the formula for finding area of a polygon. One-half the number of pegs on the polygon plus the number of pegs inside the polygon minus one equals the area.

$$\frac{E}{2} + i - 1 = \text{Area}$$

3) If students need more practice in differentiating area and perimeter, they may be given a number of square decimeter regions. They arrange them in various shapes and record area and perimeter. The figures on the next page show three examples with five square decimeters.



A = 5 dm^2
P = 12 dm

A = 5 dm^2
P = 10 dm

A = 5 dm^2
P = 12 dm

4) As a variation, students may be asked to arrange four squares so the perimeter is 8 dm and then arrange them so the perimeter is 10 dm .

5) Make a closed curve with string on a plate showing graph paper on the overhead projector. Students are to rearrange the string to show a larger (or similar) area with the same perimeter.

6) Students may estimate the number of square decimeters needed to cover the top of their desks, a portion of the bulletin board or of the blackboard. They check their estimates by covering the selected region with the square decimeters.

Pages 36 to 43 Volume

Objectives: Recognize volumes of 1 cm^3, 1 dm^3, 1 m^3.
Multiply three given dimensions to find volume.
Select cm^3 or m^3 as the best unit for finding volume.

Materials: Index cards, at least 3 cm x 4 cm
Large construction paper, at least 30 cm x 40 cm
Scissors
Centimeter ruler
Scotch tape
12 meter sticks
Masking tape
Centimeter cubes (40 per student)
Box A, 4 cm x 5 cm x 2 cm (1 per student) (See T-26 for master of box for duplicating)

Comments: Spend a few minutes talking about the idea of volume. Discuss the agreement of using cubes to find volume. (See Other activities: #1.)

Have each student make the cubic centimeter and cubic decimeter and have a model of the cubic meter in the classroom. It allows the students to familiarize themselves with these units.

It is very important for the development of finding volume that each student carefully does exercises 1 and 2. Expect that some cubes may fall off of the students' desks.

Other activities:

1) A good introductory attention-getter is to have a contest to guess the number of jelly beans or M&M's, etc. in a plastic or glass container (preferably a box). Discuss the definition of volume and the disadvantages of using jelly beans, M&M's, rice, etc. as units --leave gaps, not uniform, etc. Then, discuss the agreement of using cubes to find volume.
For motivation: If candy is used, closest guesser can win the candy.

2) Have students make a list of different boxes (by dimensions) having a common volume - such as 144 cm^3. Some would be:

12 *cm* x 12 *cm* x 1 *cm*
3 *cm* x 6 *cm* x 8 *cm*
36 *cm* x 2 *cm* x 2 *cm*

3) Challenge students with a problem such as, "It is easy to find the number of cubic centimeters in a box. Invent a way to find the number of cubic centimeters in a cup or a glass." (If they try to fill the cup with cubic centimeters they find some space not filled.)

4) In order to differentiate area and volume students may find the surface area of boxes. They may record, for example the surface area below the volume for each of the boxes in exercise 6.

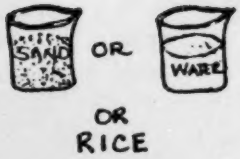
5) As a project, students may try to find materials that are sold by the cubic unit. Two examples are sand and mixed concrete.

Pages 44 to 47 Capacity

Objectives: Measure capacity of a container to the nearest unit.
Select the best approximation of a container's capacity.
Select the most appropriate unit to determine capacity of a container.

Materials: Liter measure
Graduated cylinder marked in milliliters
Water
Soda cup, juice can, milk carton, small wastepaper basket, coffee cup, soda can, mayonnaise jar

Comments: For the measurement activities, sand or rice can be used in place of water. Teachers should be checking to see that good measurement techniques are used. While a few students are working at the measurement stations, other students should be working on other parts of this lesson.



Students who have difficulty with exercise 6 should be referred back to page 23 for help with the metric prefixes.

Other activities:

1) Have students bring to class newspaper ads where liter or milliliter is stated. Use the ads for the bulletin board display.

2) Have students look for containers whose capacity is given in metric units. Have them bring the containers to class for display in the metric corner of the classroom.

3) Label five jars - A, B, C, D, E. Put a different amount of water in each of the jars. Have students order the capacities of water from greatest to least. Students can check their answers by measuring the capacity of each jar.

4) Students may collect containers of different shapes but of the same capacity. This may help them realize how consumers can be influenced to select a container which holds less than another container which appears smaller in size.

5) Students may pour water into a large plastic container. They mark and label water levels to show 1 ℓ, 2 ℓ, etc. Smaller container may be marked 0.1 ℓ, 0.2 ℓ, etc.

6) The names of containers in exercise 5 along with the appropriate measurements may be added to the bulletin board.

Pages 48 to 50 Mass

Objectives: Use the gram and kilogram scale to measure mass.
Select the most appropriate unit for determining the mass of an object.
Select the best approximation of the weight of an object.
Add and subtract decimal numbers.

Materials: Gram scale
Kilogram scale
Items to be measured: bottle, ballpoint pen, nickel, chalkboard eraser, textbooks, other objects

Comments: To keep classroom control, send students in small groups to the measuring station. Other students should be working on other parts of the lesson. For exercise 5, encourage students to select personal objects such as textbooks, handbag, wristwatch, comb, pen, etc. to measure.

Other activities:

1) Have students bring to class clippings of articles or ads that use metric mass units. Put clippings on the bulletin board. Have students bring in empty containers which give metric mass units. Display the containers in the room.

2) Have each student use the gram or kilogram scale to weigh one object that they own. The name of the object and its weight is listed on the board. Have each student construct a chart showing the mass of each object from heaviest to lightest.

3) Have students collect rocks or containers of sand. They can then have contests to determine who can arrange the objects in order from lightest to heaviest without weighing the objects.

Pages 51 to 55 Capacity and Mass

Objective: Use the gram, kilogram, liter, milliliter and their symbols.

Materials: Liter pitcher
Milliliter cylinder
Gram scale
Kilogram scale

Comments: This section provides additional practice in the measurement of capacity and mass. Students should be able to discriminate between the two measures.

In exercises 1 and 2, correct spelling and symbols should be stressed. The materials listed above should be available as a reference when students are doing exercises 5, 6, and 7.

Exercise 8 involves a field trip to a supermarket. Students should complete exercise 8a before the field trip. If a field trip is not possible, have the students look at home for items in exercises 8b-e.

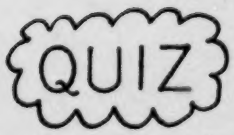
REVIEW ROUNDING

You may want to discuss the table in exercise 10 before assigning it. Also, students may need a review of rounding to the nearest gram and rounding to the nearest kilogram for exercise 11.

Other activities:

1) Have students write their favorite gelatin or punch recipe using metric units.

2) As a special project students may discover the relationship between the volume of water in cubic centimeters in a container and the weight of that water in grams. They should find that the two numbers are equal. Expect some differences due to the measurement process. To find the number of cubic centimeters in a container students may make their own measuring instrument. They mark heights on a plastic container to show 100, 200, etc. cubic centimeters. They pour into this marked container to measure the unknown amount of water.



Quiz 2 can be given at this time.

Pages 56 to 59 Temperature

Objectives: Read temperatures on a clinical and non-clinical thermometer.
Know the temperature for the freezing point of water, boiling point of water, usual temperature in Hawaii, and normal body temperature.

Select the temperature which is the best approximation for a given situation.

Materials: Celsius thermometers
Ice cubes
Dish
Glass of tap water

Comments: The Celsius thermometers for classroom use will not show normal body temperature as 37°C. Explain that the clinical thermometer is used for this purpose. To measure the temperature of a dish of ice cubes, the teacher may need to bring ice cubes in a thermos. To save time the thermometer may be placed in the glass of water and the dish of ice cubes before class begins. Then students can read the temperature from the thermometers.

Other activities:

1) Have students take the outside temperature reading at the same time each day for 20 days. Make a line graph to record their findings.

2) Students may also read the thermometer hourly for a number of days.

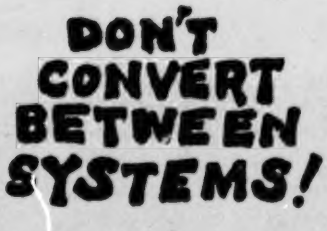
3) Have students find in the newspaper high and low temperatures for various locations in the Islands. They will find temperatures in the newspaper higher or lower than the temperatures they read at school. Why? Temperatures of various mainland and Canadian cities are also in the newspaper. Are any given in Celsius?

Pages 60 to 64 Conversions

Objective: Convert a metric measurement to another specified metric unit.

Materials: none

Comments: Linear conversions are handled first. Students are told to refer to the physical models available (their rulers) to help with establishing the pattern involved in converting metric units.



With this introduction, students are told of a shortcut. You may wish to ease this transition by providing further examples in a class discussion.

Students should find it easier to convert by counting the number of places rather than by carrying out multiplication or division by powers of ten. Conversion between systems is not recommended.

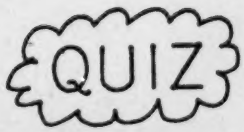
Other activities:

1) Have students play the card game "MIND*OVER*METER", a game of concentration. Cards and a rule sheet are given at the end of this outline (page T-22).

2) As a culminating activity students may fill the blanks with real life objects or situations.

Much less than 1 *m*	_____
Slightly less than 1 *m*	_____
About 1 *m*	_____
Slightly more than 1 *m*	_____
Much more than 1 *m*	_____

The 1 *m* may be replaced by 1 *l*, 1 *g*, 1 dm^2, 1 dm^3, 37 *c* or other unit the student chooses. Answers may be discussed because there could be differences of opinion. Could ice cream, for example, be sold by weight as well as by liquid measure (capacity)?



Quiz 3 can be given at this time.

Pages 65 to 66 Metric Mania

Objective: Identify metric terms and common metric prefixes through game activities.

Materials: None

Comments: These activities provide for a change-of-pace and some review. The teacher may wish to conduct a short question-and-answer period.

Pages 67 to 68 Do You Know?

Objective: Review the highlights of Measuring in metric.

Materials: None

Comments: These pages serve as a self-check on most of the objectives of the booklet. They can be used as a classroom review lesson or can be assigned as homework with time set aside for a short discussion on the following day prior to the posttest.

POST TEST

The unit test can be given at this time. You will need 5 items for the students to measure in #46-50. Some students should begin with these problems so that congestion can be avoided. Duplicate items would be helpful.

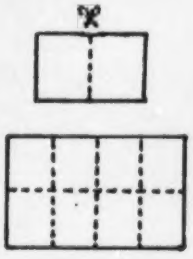
MIND*OVER*METER

The following game is a suggested "other activity" for students after completing pages 60-64.

"Mind*Over*Meter" is intended to reinforce students' conversion skills through a game format. Thus, before playing the game, students should have had the developmental work on converting linear metric units. The game is merely another way of providing the practice they need to "firm down" their understanding.

The game is a concentration-type card game. Masters for the cards and for a reference key are provided. The reference key is a card on which the matching combinations are listed. This may prove particularly useful for students who are still uncertain of their conversions, or for students to consult when selection of a matching pair is challenged by the other player(s).

Decks may be made in the following ways:



1. If only one or two decks are to be made, use 3" x 5" index cards, cut into halves, or 5" x 8" index cards, cut into eighths. Print with felt pens, being careful that printing is not visible on backs of cards.

2. If more than two decks are to be made, make ditto masters from the masters provided and run off on 8-1/2" x 11" vellum bristol or on 5" x 8" index cards. Then cut cards at lines indicated.

Rules for

MIND*OVER*METER

(A Game of Concentration)

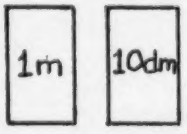
Players: 2 or 3

Materials: 1 deck of 30 Mind*Over*Meter Cards

1 Reference Key (Optional)

Object: To concentrate when the cards are turned up and to remember where each one is. Then if you find a card that matches one you have already seen, you can take the pair.

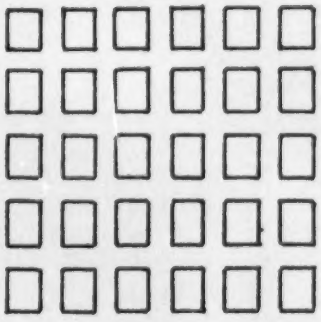
For example:



These cards match because they represent the same measurement.

Directions:

1. Shuffle the cards, being careful not to bend them.
2. Place the cards face down on the table in rows.



3. The first player turns two cards face up. If they match (measurements shown are equivalent), the player gets to keep the pair and has another turn. If they do not match, they must be turned face down again, and it is the next player's turn.
4. The players take turns turning over pairs of cards until all the cards are gone.
5. The player with the most pairs is the winner.

TO MAKE CARDS FROM 5x8" INDEX CARDS.
✂ CUT DITTO HERE →

0.01 m	1 cm	0.2 cm	0.02 dm
2 mm	0.002 m	10 mm	0.1 dm
10 km	10,000 m	1,000 dm	1 hm
1 km	1000 m	15 mm	1.5 cm

26

27

USE FULL SHEET IF RUNNING ON 8½x11" VELLUM BRISTOL

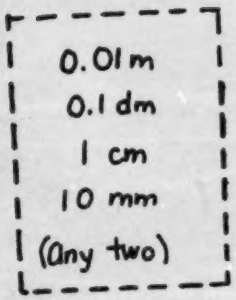
MIND*OVER*METER CARDS T-24

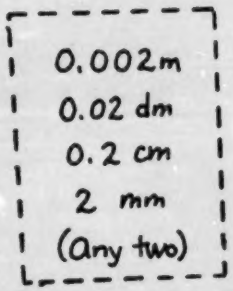
TO MAKE CARDS FROM 5x8" INDEX CARDS.
✂ CUT DITTO HERE →←✂

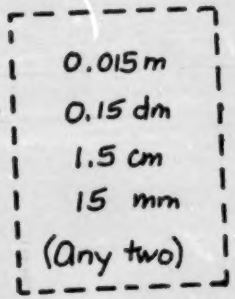
0.015 m	0.15 dm	7 mm	0.007 m
150 cm	1.5 m	1.2 km	1200 m
1 dam	10 m	0.12 m	120 mm
7 dm	70 cm		

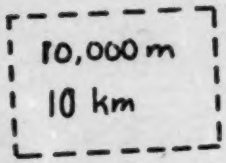
USE FULL SHEET IF RUNNING ON 8½ x 11" YELLOW BRISTOL

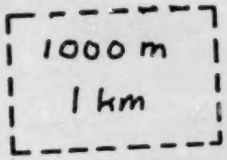
MIND OVER METER

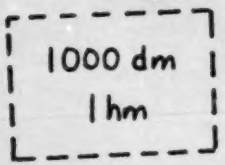


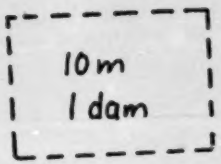


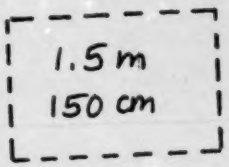


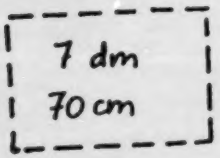


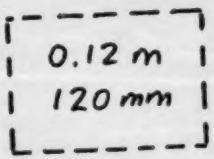


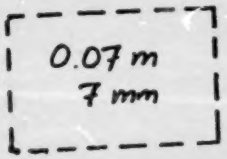








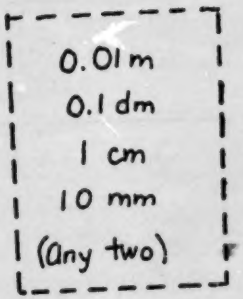


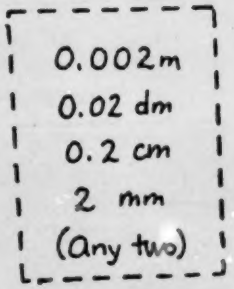


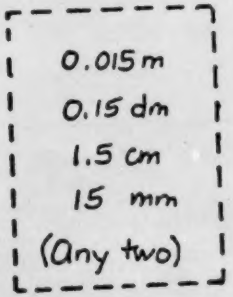
T-25

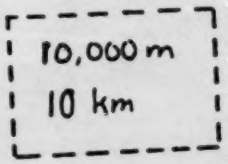
Reference Key

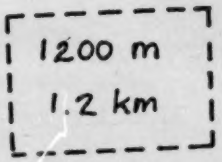
MIND OVER METER

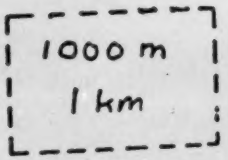


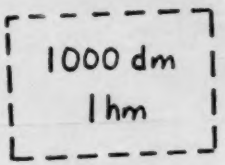


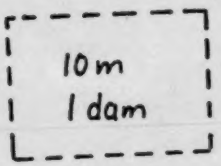


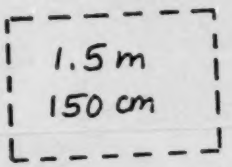


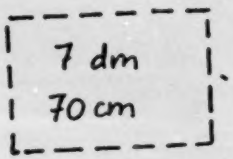


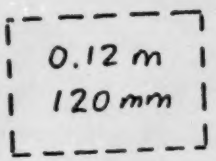


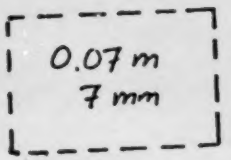






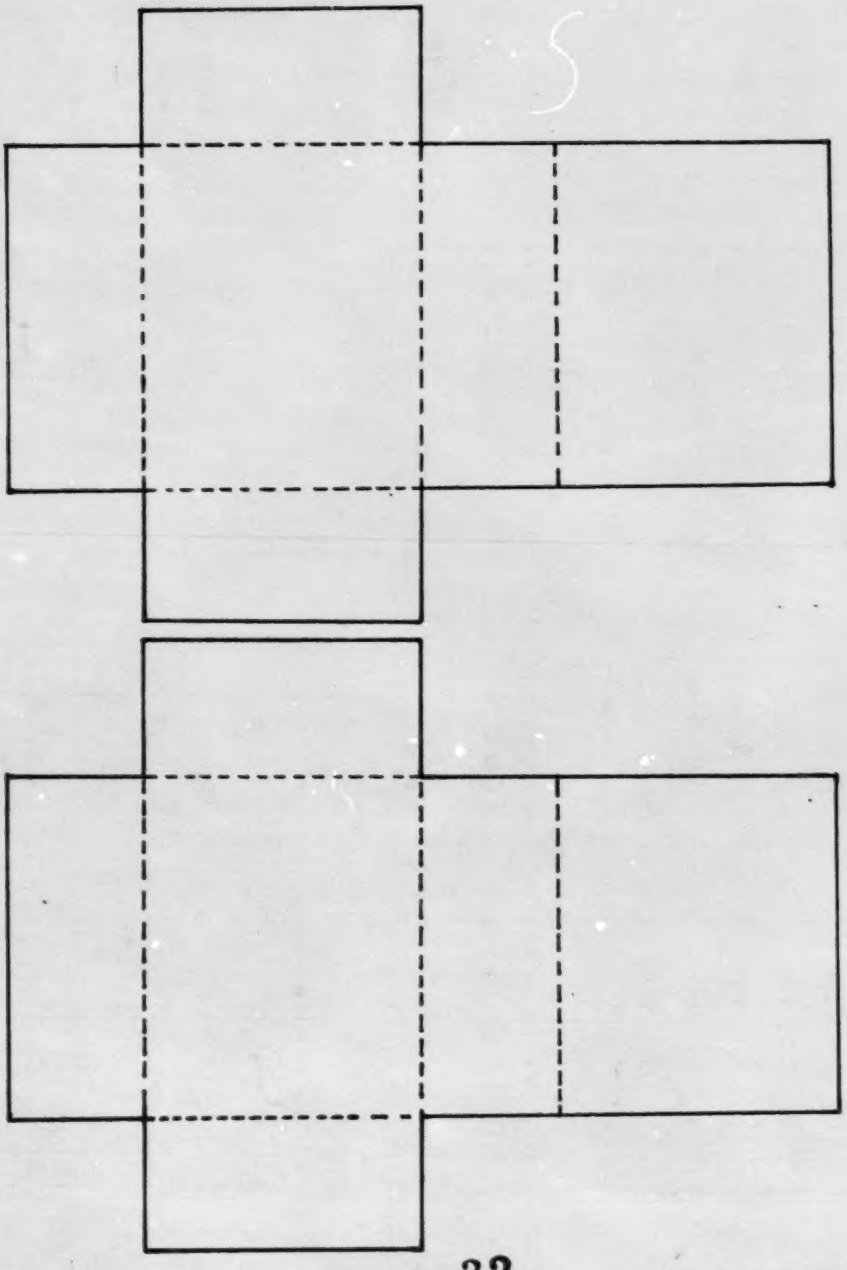






Reference Key

Master of 2 cm x 4 cm x 5 cm box used on pages 36-43



SUPPLIES AND EQUIPMENT NEEDED

Material	Material Obtained from*	Amount Needed for 30 Students	Approximate Cost per Item
Adding machine tape		1 roll	
Ballpoint pen		30	
Bottle (e.g. pill bottle)		5	
Box A (4 cm x 5 cm x 2 cm		30	
Cardboard strips (~12" x 1")		60	
Celsius thermometer	EN	15	5.95 (5/set)
Centimeter cubes	CP	1000	19.00 (1000/set)
Centimeter height measure tape	CP	1	2.50
Chalkboard eraser		3	
Coffee cup		3	
Coke can		3	
Construction Paper (12" x 18")		30	
Dime		6	
Dish		5	
Glue		6 bottles	
Graduated cylinder marked in milliliters	OH	2	3.45
Gram scale	CP	2	21.25
Ice cubes		40	
Index cards (5" x 8")		60	
Juice can		3	
Kilogram scale	OH	1	14.95
Liter pitcher	EN	2	4.95
Masking tape		1 roll	
Matchbox		2	
Mayonnaise jar		3	
Meter stick	CP	12	3.00
Milk carton		3	
Nails (labeled nail A, nail B, nail C, nail D, nail E)		30 (6 ea.)	
Nickel		6	
Oak tag (28 cm x 5 cm)		30	
Paperclip box (empty)		2	
Penny		6	
Quarter		6	
Ruler, inch		15	
Scissors		15	
Shoebox		2	
Soda cup		3	
Staples box (empty)		2	
String (60 cm long)		30	
Textbook		15	
Wastepaper basket (small)		2	
Water		~3 liters	
Yardsticks		6	

Use of the trundle wheel is optional.

* The materials purchased for the try-out of this module were from these companies:
EN - Enrich c/o H. P. Ross, 1308 Hart Street, Honolulu, HI 96817
OH - Ohaus c/o H. P. Ross, 1808 Hart Street, Honolulu, HI 96817
CP - Creative Publications, P. O. Box 10328, Palo Alto, CA 94303

Many other vendors may stock the above listed materials including the following:
Activity Resources Company, Inc., P. O. Box 4875, Hayward, CA 94540
Dick Blick, Box 1267, Galesburg, IL 61401
Creative Teaching Associates, P. O. Box 7766, Fresno, CA 93727
Cuisenaire Co. of America, Inc., 12 Church St., New Rochelle, N.Y. 10805
Ideal c/o H. P. Ross, 1308 Hart Street, Honolulu, HI 96817

QUIZ 1

1. The main metric unit of length is _____.

2. Other common metric units of length studied in this class are:

   _____

   _____

   _____

3. Name an object or a distance that is about:

   a. 1 meter long _____

   b. 1 centimeter long _____

   c. 1 millimeter long _____

   d. 8 kilometers long _____

4. Write the metric prefix which means:

   a. one thousand _____

   b. one hundred _____

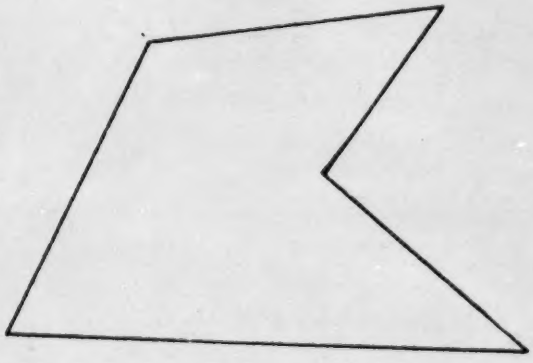
   c. ten _____

   d. one-tenth _____

   e. one-hundredth _____

   f. one-thousandth _____

5. Find the perimeter to the nearest millimeter.



P = _____

6. Circle the measurement that is closest to the actual length.

a.	Football	30 *cm*	3 *m*	60 *cm*
b.	Distance around a high school track	50 *m*	400 *m*	1000 *m*

7. Fill in the blanks.

a. 40 *mm* = _____ *cm*

b. 5.8 *cm* = _____ *mm*

c. 523 *cm* = _____ *m*

d. _____ = _____
(You make up one)

8. 37.6 *cm* + 28.43 *cm* = _____ *cm* = _____ *mm*

QUIZ 2

1. Write cm^2, m^2, or km^2 as the most appropriate unit to use to measure the area of each surface.

   a. A postage stamp _____

   b. A bedroom floor _____

   c. The island of Kahoolawe _____

   d. The amount of leather needed to make a volleyball _____

2. For each object named below, write cm^3 or m^3 as the appropriate unit for finding the volume.

   a. A classroom _____

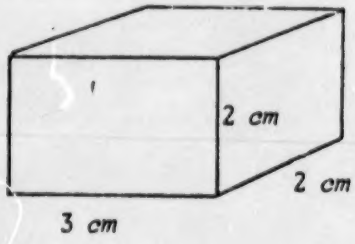
   b. An ice cream carton _____

   c. A matchbox _____

3. Find the area.

_____

4. Find the volume.



_____

5. The main metric unit of capacity is _____.

6. Write l, ml, or kl as the most appropriate unit to measure the following:

   a. Jelly jar _____ b. Washtub _____

   c. Orange soda can _____ d. Fish pond _____

7. The main metric unit of mass is _____.

8. Write g, mg, or kg as the most appropriate unit to measure the following:

   a. Yourself _____ b. Your wallet _____

   c. An aspirin tablet _____ d. Pencil _____

9. Write the numerical value of the six common metric prefixes:

   a. kilo- _____ b. hecto- _____

   c. deka- _____ d. deci- _____

   e. centi- _____ f. milli- _____

10. Circle the most appropriate measurement of capacity or mass for each object.

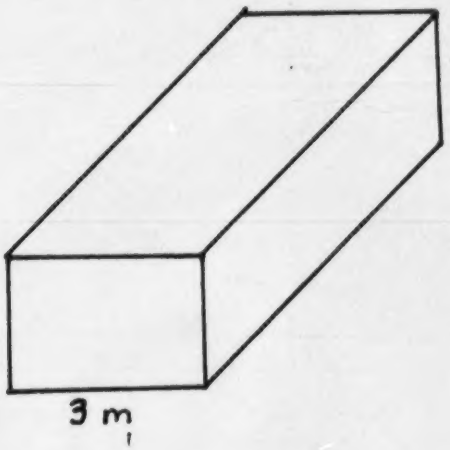
a. chalkboard eraser	50 *mg*	50 *g*	50 *kg*
b. can of rootbeer	15 *ml*	350 *ml*	3 *l*

11. Complete each statement by filling in the appropriate unit: *kg*, *g*, *mg*, *kl*, *l*, or *ml*.

a. Bill used 200 _____ of milk to make a milkshake.

b. A woman's ring weighs 4 _____.

12. Label the length and height of this box with possible measurements so it has a volume of 30 m^3. The width has been labeled 3 *m*.



QUIZ 3

1. The metric unit to measure temperature for practical situations is

_____ .

2. Write metric temperatures for the following:

   a. Freezing point of water _____

   b. Boiling point of water _____

   c. Usual Hawaiian temperature _____

   d. Normal body temperature _____

3. Select the temperature that is the best approximation for the following situations:

a. Hot day in Hawaii	22° *C*	33° *C*	55° *C*
b. Ice cream out of the freezer	-5° *C*	40° *C*	60° *C*
c. Spaghetti sauce just right for eating	10° *C*	30° *C*	70° *C*
d. Fever because of a cold	20° *C*	38° *C*	101° *C*

4. Write the six metric prefixes from largest to smallest.

			meter liter gram			

5. Use the chart in problem 4 to convert the given metric measurement to the specified metric unit.

   a. 42 *g* = _____ *cg*

   b. 2.3 *km* = _____ *m*

   c. 450 *ml* = _____ *l*

   d. 17.5 *dg* = _____ *dag*

   e. 68.4 *cm* = _____ *mm*

   f. 258.1 *dl* = _____ *hl*

MEASURING IN METRIC Name _____

TEST Date _____

Circle the best approximation.

1. The height of a door is: 1 *m* 2 *m* 3 *m*
2. A water glass holds: 2 *l* 20 *ml* 200 *ml*
3. An adult man weighs: 75 *kg* 200 *g* 150 *kg*
4. The temperature on a nice day in Hawaii is: 25° *C* 55° *C* 80° *C*

Circle the most appropriate unit for measuring.

5. Length of a pencil *mm* *cm* *m* *km*
6. Capacity of a coke can *ml* *l* *kl*
7. Weight of a bag of rice *mg* *g* *kg*
8. Area of the kitchen floor cm^2 m^2 km^2
9. Volume of an ice cream carton cm^3 m^3

Give your body measurements in metric units.

10. Your height _____
11. Your weight _____

Give metric temperatures for the following.

12. Freezing point of water _____
13. Boiling point of water _____
14. Normal body temperature _____

Name the main metric unit for:

15. Length _____
16. Capacity _____
17. Mass _____
18. Temperature _____
19. Area _____
20. Volume _____

Write the six metric prefixes and their corresponding numerical value.

	PREFIX	NUMERICAL VALUE
21.		
22.		
23.		
24.		
25.		
26.		

Write the following measurements using correct symbols.

27. Three meters _____

28. Twenty-four dekagrams _____

29. Fifteen milliliters _____

30. Twelve square centimeters _____

Circle the best approximation.

31. 1 meter is about 1 in. 1 ft. 1 yd.

32. 1 liter is about 1 pt. 1 qt. 1 gal.

33. 2 centimeters is about 1 in. 1 ft. 1 yd.

34. 1 kilogram is about 2 oz. 2 lb. 2 T.

35. 1 kilometer is about 0.6 yd. 0.6 rd. 0.6 mi.

Covert the given metric measurement to the specified unit.

36. 2 *m* = _____ *cm*

37. 35 *ml* = _____ *l*

Find the sum.

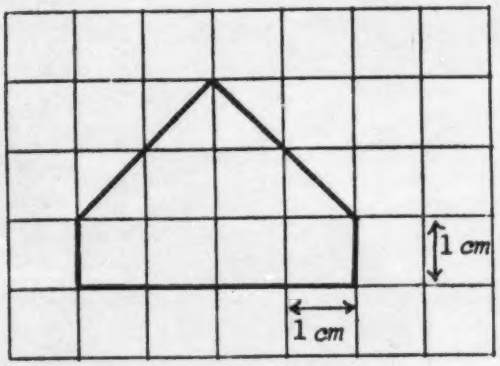
38. 45.976 + 8.23 = _____

Find the difference.

39. 28.05 - 1.708 = _____

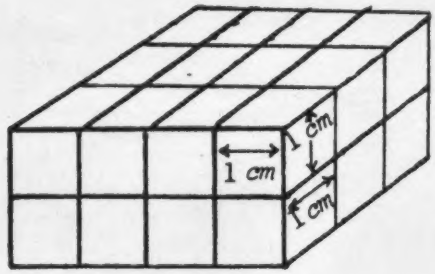
Find the area. _____

40.



Find the volume. _____

41.

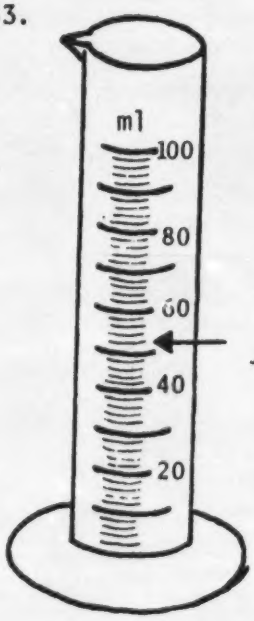


Read the following measurements.

42.

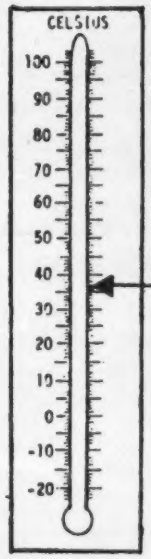
_____

43.



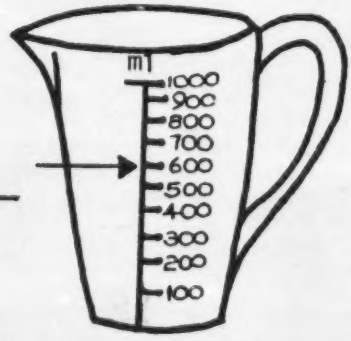
_____

44.



_____

45.



_____

Name _____

Date _____

Measure the items marked A, B, C, D, and E. Write the name of the item to be measured and write its measurement in the chart below.

		NAME	MEASUREMENT
46.	ITEM A		
47.	ITEM B		
48.	ITEM C		
49.	ITEM D		
50.	ITEM E		

ANSWER KEY

For easy referral, it is suggested that the teacher use a red or blue-colored pen or pencil to write the answers in his/her copy of the metrics student book.

Metric Rulers, pages 3-5

1. 40 *mm* 2. 50 *mm* 3. 25 *mm* 4. 32 *mm* 5. 10 *mm*
6. 270 *mm* 7. 156 *mm* 8. 109 *mm* 9. 231 *mm* 10. 7 *mm*
11. 1 *dm* 12. 20 *cm* 13. 100 *cm* 14. 10 *dm* 15. 100 *cm*
16. One meter is longer than one yard. 17. One meter is about 1 *dm* OR 8 *cm* OR 3 inches longer than one yard.
18. One inch is longer than one centimeter.
19. One inch is about 2.5 centimeters. 20. 5 *cm* is about 2 inches.
21. 10 *cm* 22. 100 *mm* 23. 10 *mm* 24. 100 *cm* 25. 1000 *mm*

ANSWERS WILL VARY FOR THE OBJECTS NAMED IN THE THREE EXERCISES THAT FOLLOW.

Length (The Meter), pages 6-8

1. Answers may vary. These are the most probable answers:
   a. longer than one meter b. about one meter c. shorter than one meter
   d. shorter than one meter e. shorter than one meter f. about one meter
   g. longer than one meter h. about one meter
2. Answers will vary. 4. Answers will vary. 5. Answers will vary.
6. Answers will vary. 7. Answers will vary.
8. a. 5 *m* b. 4 *m* c. 2 *m* d. 17 *m* e. 4 *m* f. 5 *m*
   g. 8 *m* h. 1 *m* i. 10 *m*
9. Some suggested answers are:
   a. Height of washer or dryer, width of bed or crib, length of desk, etc.
   b. Length of teacher's desk, height of chalkboard, width of door, width of window, etc.
   c. height of fence, height of hedge, distance from ground to tetherball, etc.
   d. golf club, baseball bat, width of volleyball net, etc.
   e. width of shower stall, eave of a house, width of hallway, etc.
   f. height of motorcycle, width of telephone booth, etc.
10. **** *For a classroom* 8 *m* x 9 *m* x 3 *m, shortest web is approximately* 13 *m* ($\sqrt{64 + 81 + 9}$).

Length (The Centimeter), pages 9-11

1. Answers will vary for the estimations and differences. The measurements are as follows: a. 4 *cm* b. 3 *cm* c. 5 *cm* d. 5 *cm* e. 6 *cm*
2. 23 *cm*; 3 *cm*
3. Drawings using centimeter ruler: a.
   b.
   c.
   d.

Length (The Centimeter), pages 9-10 continued

4. a. 5 *cm* b. 6 *cm* c. 11 *cm* 5. Answers will vary.

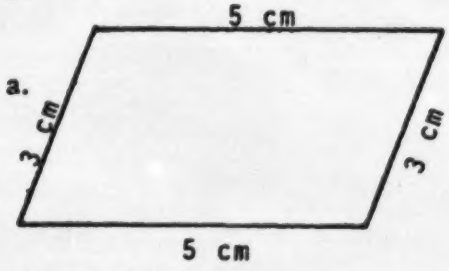
6. Answers will vary. 7. **** *If the width of the room is 8 m, the 2-cm worm reaches the other end at 9:40.*

(2 x 10 = 20 cm/min.; 800 cm ÷ 20 cm/min. = 40 min.)

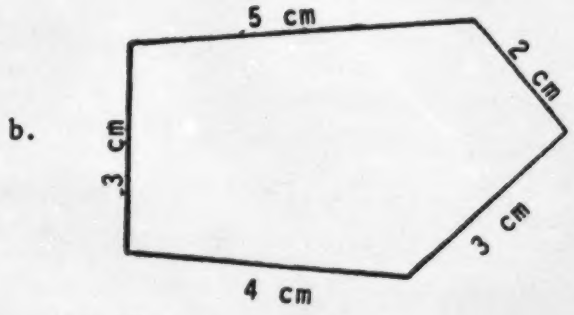
Perimeter, pages 12-14

1. 9 *cm* b. 12 *cm*

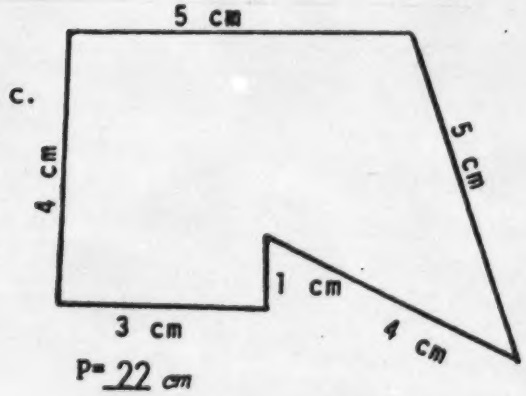
2.



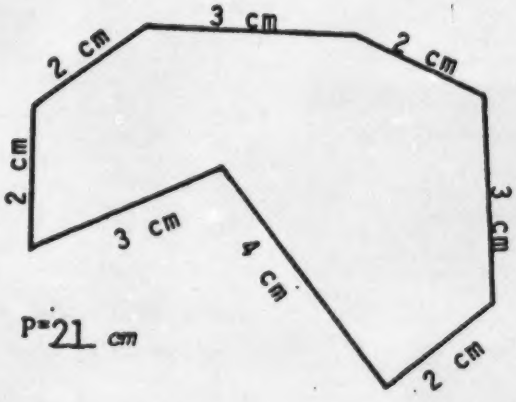
P= 16 *cm*



P=17 *cm*



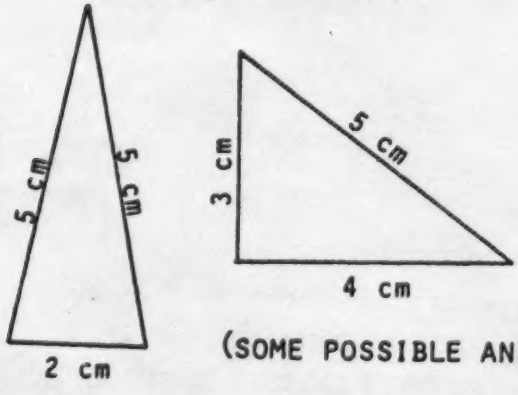
P= 22 *cm*



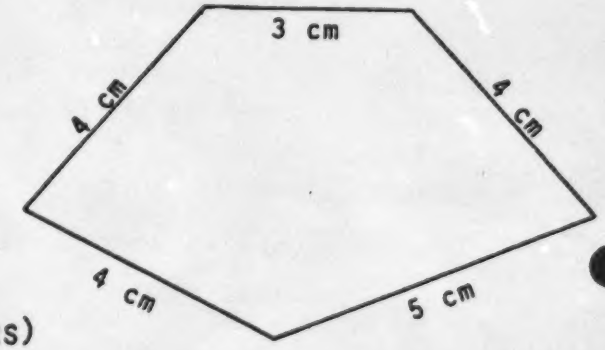
P=21 *cm*

3.

a. 3 sides; perimeter 12 *cm*



b. 5 sides; perimeter 20 *cm*



(SOME POSSIBLE ANSWERS)

Perimeter, pages 12-14 continued

4. Answers will vary 5. Answers will vary. 6. Answers will vary.

7. Baseball diamond: P=120 *m*; Football field: P=320 *m*;
Olympic-size swimming pool: P=150 *m*

8. **** *Deci 54.3 cm ; Centi 51.8 cm ; Milli 52.9 cm ; Kilo 56.1 cm ; Hecto 54.0 cm ; Deka 52.6 cm*

Length (The Millimeter), pages 15-17

1. Answers will vary.

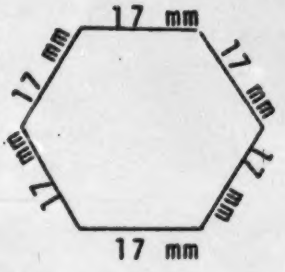
2.

COIN	DIAMETER MEASUREMENT	THICKNESS
Penny	*19 mm*	*1 mm*
Nickel	*21 mm*	*2 mm*
Dime	*18 mm*	*1 mm*
Quarter	*24 mm*	*2 mm*

3. a.

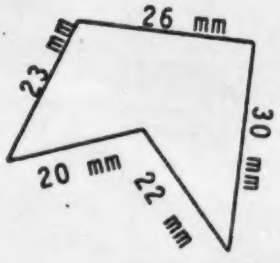
P = 85 mm

c.



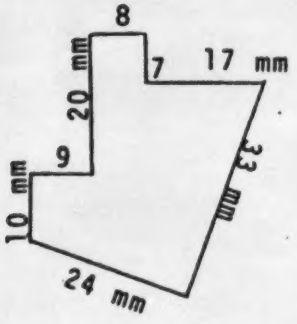
P= 102 mm

b.



P= 121 mm

d.



P= 128 mm

4. Answers will vary.

5. a. 14.8 b. 18.847 c. 9.44
d. 1.47 e. 852.29 f. 90.002

6. *** *Dale is about 14 mm , and Gale is about 13 mm .*

**** *It would take the snail 24 days to get out. (230 ÷ (30 - 20) = 23 days to go the distance 230 mm , and the next day to get out.)*

Length (The Kilometer), pages 18-22

1.

MILES	KILOMETERS
10	10 + 5 + 1 = 16
20	20 + 10 + 2 = 32
30	30 + 15 + 3 = 48
40	40 + 20 + 4 = 64
50	50 + 25 + 5 = 80
60	60 + 30 + 6 = 96
70	70 + 35 + 7 = 112
80	80 + 40 + 8 = 128
90	90 + 45 + 9 = 144
100	100 + 50 + 10 = 160
110	110 + 55 + 11 = 176
120	120 + 60 + 12 = 192

2. b. 8 *km* c. 26 *km* d. 80 *km*
e. 83 *km* f. 40 *km*

128 *km* 122 *km* 96 *km*
94 *km* 86 *km*

3. DISTANCES BETWEEN THE HAWAIIAN ISLANDS

	HAWAII	KAUAI	LANAI	MAUI	MOLOKAI	OAHU
KAUAI	260 mi. 416 km	X	170 mi. 272 km	190 mi. 304 km	150 mi. 240 km	80 mi. 128 km
LANAI	70 mi. 112 km	170 mi. 272 km	X	10 mi. 16 km	10 mi. 16 km	50 mi. 80 km
MAUI	30 mi. 48 km	190 mi. 304 km	10 mi. 16 km	X	10 mi. 16 km	70 mi. 112 km
MOLOKAI	90 mi. 144 km	150 mi. 240 km	10 mi. 16 km	10 mi. 16 km	X	30 mi. 48 km
OAHU	140 mi. 224 km	80 mi. 128 km	50 mi. 80 km	70 mi. 112 km	30 mi. 48 km	X
NIIHAU	300 mi. 480 km	20 mi. 32 km	210 mi. 336 km	230 mi. 368 km	190 mi. 304 km	120 mi. 192 km

Length (The Kilometer), pages 18-22 continued

4. Some examples are: a. Makaha to Makua; Waianae to Nanakuli; Kahuku to Hauula
   b. Aiea to Waipahu; Hauula to Kahana

5-9. Answers will vary.

10. **** *If they travelled at a constant speed of 80 km/hr., they reached Makaha at 10:12 . (32 ÷ 80 = 1/5; 1/5 x 60 min. = 12 min.)*

Length, pages 23-27

1 *km* = 1000 *m* ; 1 *hm* = 100 *m* ; 1 *dam* = 10 *m* ; 1 *dm* = 0.1 *m* ;
1 *cm* = 0.01 *m* ; 1 *mm* = 0.001 *m*

1. one-tenth, 0.1 *m* ; one hundred times, 100 *m* ; one-thousandth, 0.01 *m* ; one thousand times, 1000 *m* ; one-hundredth, 0.001 *m* ; ten times, 10 *m*
2. one-hundredth, $0.01 or 1¢; one-tenth, $0.10 or 10¢; one thousand times, $1000.00; one-thousandth, $0.001 or 0.1¢ or 1 mill
3. one-thousandth, 1000 millimeters; one-hundredth, 100 *cm* ; one-tenth, 10 *dm*
4. a. centi b. hecto c. milli d. kilo
5.

LINE SEGMENT	ESTIMATE	MEASUREMENT
	_____ *cm* _____ *mm*	4 *cm* 39 *mm*
	_____ *cm* _____ *mm*	1 *cm* 14 *mm*
	_____ *cm* _____ *mm*	8 *cm* 75 *mm*

6. a. 160 *cm* b. 18 *m* c. 192 *mm* d. 6 *cm* e. 5 *m* f. 12 *m*
7. a. *m* b. *mm* or *cm* c. *km* d. *m* e. *km*
8. a. *m* b. *cm* c. *m* d. *km* e. *cm*
9. a. Length of a bed b. Diameter of a dinner plate; Length of a football
   c. Diameter of a penny; Width of a dollar bill d. Length of a whale (possible answer for some whales); Height of a mango tree
10. a. meter b. *cm* c. millimeter d. kilometer
11. Answers will vary. 12. a. M b. L c. A d. M e. L f. M g. L h. A
13. a. L b. A c. M d. L e. L or A f. L g. L h. L i. Answers will vary.
14. a. L b. Answers will vary. c. A d. Answers will vary. e. L f. M
    g. M h. M 15. Answers will vary.
16. a. 11.70 b. 43.32 c. 14.574 d. 8.97 e. 64.375
    f. 19.74 g. 0.225 h. 6.633 i. 0.551 2 j. 1.26

Area, pages 28-35

Answers will vary for the activity involving making a square decimeter.

1. a. 4.5 cm^2 b. 18 cm^2 c. 4 cm^2 d. 7 cm^2 e. 12.5 cm^2
f. 5.5 cm^2 2. Answers will vary.
3. b. 7.5 cm^2 c. 19 cm^2 d. 9 cm^2 e. 12 cm^2 f. 14 cm^2
4. a. cm^2 b. km^2 c. cm^2 d. cm^2 e. mm^2 f. m^2 g. cm^2 h. cm^2
i. mm^2 j. m^2 k. m^2 l. cm^2 5. a. about 39 cm^2 b. 42 cm^2 c. 38 cm^2
6. Answers will vary. NOTE: Have the students outline their hands with their fingers together to make counting the surface area easier.
7. a. A = 3 cm^2 ; P = 9 cm b. A = 8 cm^2 ; P = 16 cm c. A = 16 cm^2 ; P = 16 cm 10. **** *2,088 pieces of tile (920 ÷ 23 = 40, 1,200 ÷ 23 = 52 r 4 cm A tile can be cut to give 5 strips of 4 cm width. 8 tiles cut into 4-cm strips gives 40 strips. Therefore, 40 x 52 ÷ 8 = 2,088)*
8. Answers will vary.
9. a. 25 cm^2 b. Answers will vary.
c. 6.25 cm^2 c. $\frac{1}{4}$

Volume, pages 36-43

3. a. cm^3 b. m^3 c. m^3 d. cm^3 e. cm^3 f. cm^3
4. a. 27 cubes b. 18 cubes c. 24 cubes d. 32 cubes
5. a. 4 cubic centimeters b. 5 rows; 20 cubic centimeters c. 2 layers
d. 40 cubic centimeters; 4 x 5 x 2 = 40
6. a. 24 cm^3 b. 60 cm^3 c. 24 cm^3 d. 160 cm^3 e. 56 cm^3
f. 60 cm^3 g. 384 cm^3 h. 420 cm^3 i. 648 cm^3 j. 1600 cm^3
7. Answers will vary. 8. a. 45 m^3 b. 60 m^3 c. 48 m^3 d. 80 m^3
e. 112 m^3 f. 144 m^3 9. a. 1 000 cubic centimeters
b. 1 000 cubic decimeters **c. 1 000 000 cubic centimeters
10-12. Answers will vary.
13. **** *20 people (1 300 000 - 60 000 = 21; 21 - 1 = 20 , -1 for space taken by the telephone)*

Capacity, pages 44-47

1. a. 0.001, 0.001 b. less than, very small c. 1000, 1 000
d. more than, very large 2. a. ml b. ml or l c. ml
d. kl e. l f. kl g. l h. ml i. ml j. l
3. Answers will vary. 4. a. 95 ml b. 80 ml c. 63 ml
d. 40 ml e. 29 ml f. 12 ml g. 800 ml h. 460 ml i. 240 ml
j. 80 ml 5. a. 500 ml b. 8 l c. 50 l d. 200 ml
e. 4 l f. 240 ml g. 400 l h. 4 l i. 1 ml j. 300 ml
6. a. kilo- b. hecto- c. deka- d. deci- e. centi- f. milli-
7. 1 000 l = 1 kl ; 100 l = 1 hl ; 10 l = 1 dal ; 0.1 l = 1 dl ;
0.01 l = 1 cl ; 0.001 l = 1 ml 8. a. 3 000 l b. 400 l
c. 50 l d. 2 l e. 0.3 l f. 0.5 l 9. Answers will vary.

Capacity, pages 44-47

10. **** *Here are some possible solutions:*

(1) $5\ l + 5\ l = 10\ l$
$10\ l - 3\ l - 3\ l = 4$ *liters*

(2) $5\ l + 3\ l + 3\ l = 11\ l$
$11\ l - 5\ l - 5\ l = 1\ l$
$3\ l + 1\ l = 4$ *liters*

Mass, pages 48-50

1. b. 500 *g* c. 1 000 *g* d. 0.175 *kg* e. 20 000 *g* f. 0.450 *kg*

2. Answers will vary. 3. a. *kg* b. *g* c. *kg* d. *kg*

e. *mg* f. *g* 4. a. *g* b. *kg* c. *kg* d. *g*

5. Answers will vary. 6. a. 36.1 b. 16.13 c. 7.519

d. 136.97 e. 31.685 f. 70.523 7. a. 12.1 b. 7.62

c. 3.9 d. 21.37 e. 3.022 f. 11.194 8. Answers will vary.

9. **** *In three measurements:* *(1)* 4 4 *If they balance, the odd one is light. If not, remeasure lighter side and the light ball is found.*

(2) 2 2

(3) 1 1

**** *In two measurements:* *(1)* 3 3 *If balanced, take the remaining 3 and the light ball is found. If not, take the lighter of the two groups measured and the light ball is found.*

(2) 1 1

Capacity and Mass, pages 51-55

1.

NAME	SYMBOL
LITER	l
MILLILITER	ml
KILOLITER	kl
HECTOLITER	hl
DEKALITER	dal
DECILITER	dl
CENTILITER	cl

2. a. 2 *l* b. 1 500 *ml* c. 12 *l* d. 3 *l*

3.

NAME	SYMBOL
GRAM	g
KILOGRAM	kg
MILLIGRAM	mg
CENTIGRAM	cg
DECIGRAM	dg
DEKAGRAM	dag
HECTOGRAM	hg

4. a. 2 *kg* b. 5 *kg* c. 3 000 *g* d. 1 *kg*

Capacity and Mass, pages 51-55 continued

5. a. pencil b. 1/2-gallon milk carton c. 2 paper clips
d. bowling ball e. teaspoon f. adult's weight

6. a. no b. yes c. no d. yes e. no f. yes

7. a. telephone book; newborn baby b. cup of orange soda; bottle of catsup

8. a.

Fill in the name of the metric unit.	Cross out all incorrect symbols. (HINT: There is only one correct symbol in each row.)					
kilogram	~~KG~~	~~kG~~	~~kg.~~	kg	~~Kg.~~	~~Kg~~
millimeter	mm	~~MM~~	~~Mm.~~	~~mM~~	~~mm.~~	~~Mm~~
centimeter	~~CM.~~	~~Cm~~	~~cM~~	cm	~~cm.~~	~~CM~~
gram	~~gs.~~	g	~~gm~~	~~gm~~	~~gr~~	~~gm.~~
meter	~~M~~	~~M~~	m	~~met.~~	~~mett.~~	~~mt~~
liter	~~ld~~	~~L~~	l	~~L~~	~~lit.~~	~~L~~
milliliter	~~ML~~	~~mKl~~	ml	~~mKl.~~	~~mL~~	~~ML~~
milligram	~~MGS~~	~~mgs~~	~~mgm~~	~~MG~~	~~mgr.~~	mg
kilometer	km	~~KM~~	~~Km~~	~~Km~~	~~Km~~	~~KM~~

b - e. Answers will vary.

9. a. 4.41 b. 0.986 c. 15.05 d. 15.5

10. Mars 40 *g* ; Uranus 90 *g* ; Neptune 120 *g*

11.

	EARTH	MOON	JUPITER	MARS	URANUS	NEPTUNE
Astronaut	72 *kg*	12 *kg*	187 *kg*	29 *kg*	65 *kg*	86 *kg*
4 books	600 *g*	100 *g*	1560 *g*	240 *g*	540 *g*	720 *g*
Jeep	1 400 *kg*	234 *kg*	3 640 *kg*	560 *kg*	1260 *kg*	1 680 *kg*
TV set	40 *kg*	7 *kg*	104 *kg*	16 *kg*	36 *kg*	48 *kg*
Refrigerator	220 *kg*	37 *kg*	572 *kg*	88 *kg*	198 *kg*	264 *kg*
Dog	25 *kg*	4 *kg*	65 *kg*	10 *kg*	23 *kg*	30 *kg*
You		ANSWERS WILL VARY				

12. **** *Crackers - 1 kg is a lot of crackers.*
Punch syrup - about 2 gallons
Potato chips - 15 kg is unreasonable.
Peaches - 10 g is too light.
Hot dog - 1 gam wouldn't feed a baby.
Cola - 1 liter cans are not made.
Mustard - 1 liter would be restaurant supply.
Butter - too light
7-Up - A large bottle is about 1 liter.

Temperature, pages 56-57

1. a. 38° C b. 50° C c. 15° C d. 60° C e. 1535° C
f. 40° C g. 0° C h. 70° C i. 28° C j. -20° C
2. a. A 70° C ; B 35° C b. A 86° C ; B 0° C c. A 69° C ; B 24° C d. A 37° C ; B -11° C
3. b. c. d.

Temperature, pages 58-59

1. Answers will vary. 2. b. Snowstorm in the Midwest; Temperature in freezer compartment c. Normal body temperature; Warm bathwater
d. Temperature for baking a cake; Outdoor campfire
3. a. 42.5° C b. 40.9° C c. 39.1° C d. 37.0° C e. 35.3° C
f. 41.6° C g. 40.2° C h. 38.4° C i. 36.8° C j. 35.5° C
4. Answers will vary. 5. **** 730° C (480° + 250°)

Converting Metric Units of Length, pages 60-61

1. 40 *mm* 2. 45 *mm* 3. 1.5 *cm* 4. 230 *mm* 5. 10.5 *cm*
6. 100 *mm* 7. 2 *dm* 8. 2.5 *dm* 9. 10 *cm* ; 1 *cm* is 1/10 of a decimeter.
10. 10 *mm* ; 1 *mm* is 1/10 of a centimeter. 11. 100 *mm* ; 1 *mm* is 1/100 of a decimeter.
12. 0.12 *dm* 13. 0.43 *dm* 14. 4.3 *dm* 15. 8.3 *dm* 16. 0.07 *dm*
17. 13 *cm* 18. 0.008 *m* = 0.08 *dm* = 0.8 *cm* = 8 *mm*
19. 0.15 *m* = 1.5 *dm* = 15 *cm* = 150 *mm*
20. 30 *m* = 300 *dm* = 3 000 *cm* = 30 000 *mm*
21. 1.95 *m* = 19.5 *dm* = 195 *cm* = 1 950 *mm* 22. 15 *cm*
23. 30 000 *mm* 24. 1.95 *m* 25. 300 *cm* 26. 46 *dm* 27. 5.5 *m*
28. 0.225 *m* 29. 0.2 *m* 30. 1.4 *km* 31. 360 *mm* 32. 1.12 *dm*
33. 210 *m* 34. 458.9 *dam* 35. 5.9 *dm* = 590 *mm*
36. 25 *cm* + 3 *cm* + 4 *cm* = 32 *cm* = .32 *m* 37. 6 480 *mm* = 6.48 *m*
38. 4.9 *cm* = 49 *mm* 39. 1 500 *mm* - 966 *mm* = 2 466 *mm* = 2.466 *m*
40. 712 *cm* = 71.2 *dm*

Converting Metric Units, pages 62-64

1. 0.007 *kl* 2. 1.033 *m* 3. 23 *hm* 4. 0.25 *l* 5. 4 750 *dg*
6. 1.5 *km* 7. 2 800 *ml* 8. 28 000 *g* 9. 91.4 *hg* 10. 62 500 *l*
11. 750 *m* 12. 2 100 *cl* 13. 0.22 *kg* 14. 0.62 *hl*
15. a. 47.66 *g* ; 47 660 *mg* b. 430.71 *g* ; 0.430 71 *mg*
c. 20.511 *m* ; 2 051.1 *cm* d. 127.87 *ml* = 0.127 87 *l*
e. 623.95 *cm* = 0.623 95 *dam* 16. b. 3 000 *ml* and 450 *ml* = 3 450 *ml*
c. 1 000 *g* and 2 568 *g* = 3 568 *g* d. 200 *cm* and 30 *cm* and 65 *cm* = 295 *cm*
e. 20 000 *cl* and 1 500 *cl* and 456 *cl* = 21 956 *cl*
17. a. 1.5 *km* b. 300 *hm* c. 890 *cm*
18. a. 2.54 *cm* = 0.025 4 *m* ; 1610 *km* = 1 610 000 *m*
b. 28 *mg* = 0.028 *g* ; 2.2 *kg* = 2 200 *g*
19. Answers will vary.

Metric Mania, pages 65-66

1.

M	Y	S	T	I	N	U	E	R	A	U	Q	S	A	R	T	E	M
E	N	C	U	B	I	C	R	E	T	E	M	I	C	E	D	A	I
T	I	T	S	U	T	B	A	T	O	V	R	C	E	N	T	I	L
S	V	S	Y	S	U	D	E	C	I	M	E	A	G	S	N	A	L
Y	O	H	S	H	A	C	O	M	P	A	T	P	A	C	R	N	I
S	L	E	M	E	T	M	I	L	L	T	E	A	N	E	T	E	L
C	U	T	R	R	D	A	V	E	G	H	M	C	A	P	A	C	I
I	M	O	E	G	L	O	N	O	S	Q	I	I	N	C	P	E	T
R	E	G	T	H	E	G	T	Y	L	E	L	T	C	E	R	M	E
T	R	E	I	E	T	O	S	T	N	J	L	Y	R	U	H	P	R
E	A	T	L	H	P	C	A	P	G	O	I	H	T	I	T	E	M
M	S	R	I	B	I	R	E	A	T	H	M	A	E	S	G	R	A
H	E	C	T	O	L	I	T	E	R	N	R	P	S	Q	R	T	R
A	D	N	I	L	N	A	R	G	T	E	S	T	N	U	A	U	G
R	E	T	E	M	C	E	N	T	P	M	I	L	O	G	M	R	O
W	I	D	C	E	N	T	I	M	E	T	E	R	O	T	H	E	L
O	L	I	K	R	E	T	E	M	O	L	I	K	I	M	E	T	I
D	E	C	I	M	A	T	S	U	I	S	L	E	C	O	L	I	K

2. a. military b. centipede c. Mililani or Makakilo d. Desi Arnez
e. Kilauea f. kilowatt 3. a. gram b. decimeter c. volume
d. kilometer e. metric system f. dekameter g. kilogram
h. liter i. hectometer j. length k. millimeter l. meter
m. weight n. milligram

Metric Mania, pages 65-66 continued

4. a. 0.7 *m* b. 1.4 c. 2.1
   d. 2.8 e. 3.5 f. 4.2
   g. 4.9 h. 5.6 i. 6.3

5.6	0.7	4.2
2.1	3.5	4.9
2.8	6.3	1.4

Do You Know?, pages 67-68

1.

kilo-	1 000
hecto-	100
deka-	10
deci-	0.1
centi-	0.01
milli-	0.001

2.

meter	*m*
centimeter	*cm*
millimeter	*mm*
kilometer	*km*

3. cm^2
4. cm^3
5. Answers will vary.
6. Answers will vary.
7. 37° C

8.

liter	*l*
milliliter	*ml*
kiloliter	*kl*

9.

gram	*g*
kilogram	*kg*
milligram	*mg*

10. meter: about one yard; centimeter: about 2 makes one inch; kilometer: about 2 makes one mile; liter: about one quart; kilogram: about 2 pounds
11. 4 550
12. 1 meter: baseball bat, golf club, width of door, floor to waist, etc.
    1 centimeter: width of paper clip, diameter of chalk, width of fingernail, etc.
    1 kilometer: Ilikai to Ward Warehouse, etc.
    1 liter: quart of milk, small saucepan, large juice can, etc.
    1 kilogram: history textbook, sirloin steak, etc.
    25° C : classroom temperature, nice day, ocean water temperature at Ala Moana, etc.

QUIZ 1

1. meter
2. Any three of the following units of length are acceptable: meter, centimeter, millimeter, kilometer
3. a-d. Answers will vary.
4. a. kilo- b. hecto- c. deka- d. deci- e. centi- f. milli-
5. P = about 24 *mm*
6. a. 30 *cm* b. 400 *m*
7. a. 4 *cm* b. 58 *mm* c. 5.230 *m* d. Answers will vary
8. 66.03 *cm* = 660.3 *mm*

QUIZ 2

1. a. cm^2 b. m^2 c. km^2 d. cm^2 2. a. m^3 b. cm^3
c. cm^3 3. 5.5 cm^2 4. 12 cm^3 5. liter 6. a. ml
b. l c. ml d. kl 7. gram 8. a. kg b. g
c. mg d. mg 9. a. one thousand b. one hundred c. ten
d. one-tenth e. one-hundredth f. one-thousandth
10. a. 50 g b. 350 ml 11. a. ml b. g
12. Either 3 m x 2 m x 5 m OR 3 m x 1 m x 10 m

QUIZ 3

1. degree Celsius 2. a. 0° C b. 100° C c. 20° - 30° C d. 37° C
3. a. 33° C b. -5° C c. 30° C d. 38° C
4. kilo- hecto- deka- deci- centi- milli-
5. a. 420 cg b. 2 300 m c. 0.45 l d. 0.175 dag e. 6 840 mm
f. 0.258 1 hl

TEST

1. 2 m 2. 200 ml 3. 75 kg 4. 25° C 5. cm 6. ml
7. kg 8. m^2 9. cm^3 10. Answer will vary. 11. Answer will vary.
12. 0° C 13. 100° C 14. 37° C 15. meter 16. liter
17. gram 18. degree Celsius 19. cm^2 20. cm^3
21. kilo- ; 1 000 22. hecto- ; 100 23. deka- ; 10
24. deci- ; 0.1 25. centi- ; 0.01 26. milli- ; 0.001
27. 3 m 28. 24 dag 29. 15 ml 30. 12 cm^2 31. 1 yd.
32. 1 qt. 33. 1 in. 34. 2 lb. 35. 0.6 mi. 36. 200 cm
37. 0.035 l 38. 54.206 39. 26.342 40. 8 cm^2 41. 24 cm^3
42. 75° C 43. 52 ml 44. 37° C 45. 600 ml
46-50. Answers will vary.